

WFS(-T) in the SensorNet



Overview

- Quick review of GML & WFS.
- GML Observation
- WFS (-T) for Sensor Data
- WFS, WRS and the SensorNet

Some GML & WFS Basics

Quick Review



What is GML? – Strategic Perspective

- International standard (OGC & ISO)
- An XML grammar for describing geographic objects – a DDL for geography.
- A language to write “geographic” languages
- Written in XML Schema – extensibility.
- Designed to support geographic transactions not just file transfer.
- Simple model – objects-property-value.
- Rich collection of base/primitive objects.
- Inherently self describing.

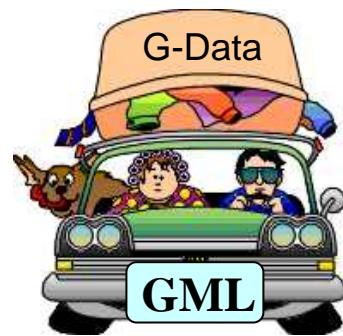
GML – Who is interested?

- Most OGC Specifications depend on it. (Filter, WFS, SensorML ...)
- NATO
- US Census Bureau.
- UK MOD/Met Office/UKHO
- ICC (Spain)
- Statistics Canada
- European Space Agency
- EUSC (Spain)
- All GIS vendors (ESRI, Intergraph, Oracle ..)
- Google KML (Cut & Paste)
- Canadian Geological Survey
- Dutch Cadastre
- Statistics Canada
- ICC (Spain)
- MNR (Ontario), MLA (BC), MF (BC)
- Shell Oil (Netherlands)
- SpaceBel (Belgium)
- EuroControl & FAA (AIXM)
- Jeppesen (IAXS)
- US DOT and State DOT (Transxml)

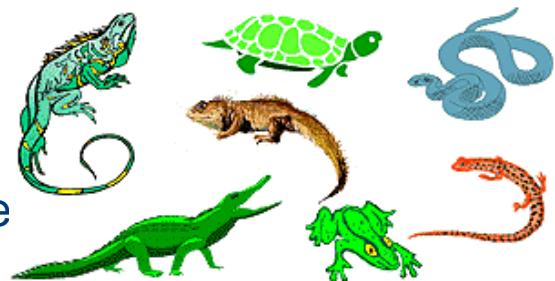
What is GML - what does it do?



Express schemas for sharing & query construction.

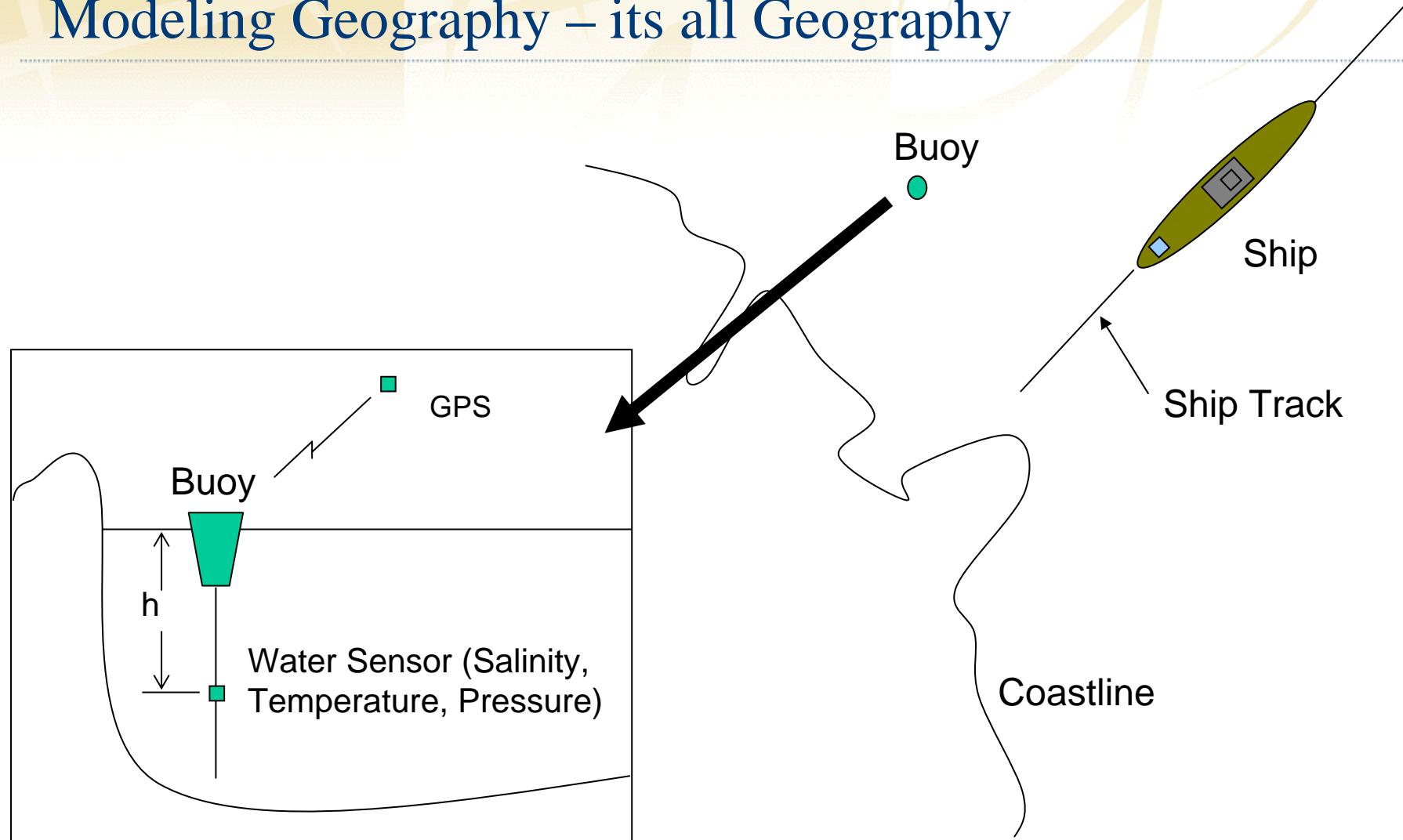


Lingua Franca – Data transport – transaction view.

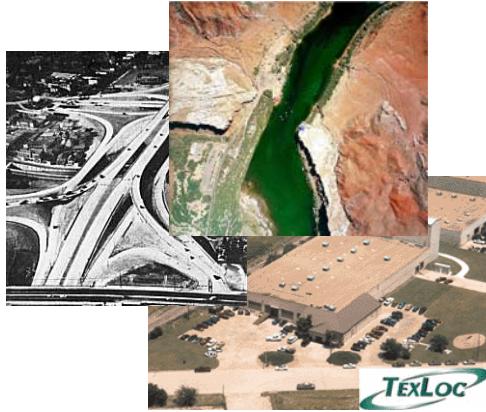


Express Geospatial types for specialized web service

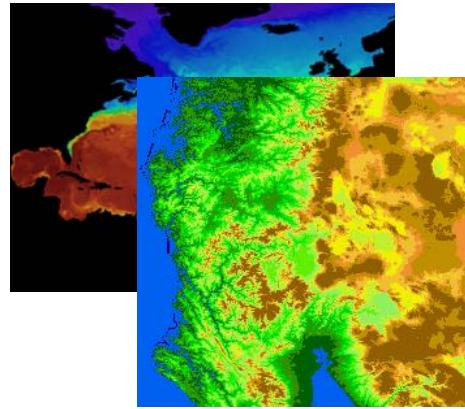
Modeling Geography – its all Geography



Modeling Geography – its all Geography !



Discrete meaningful objects (Features)



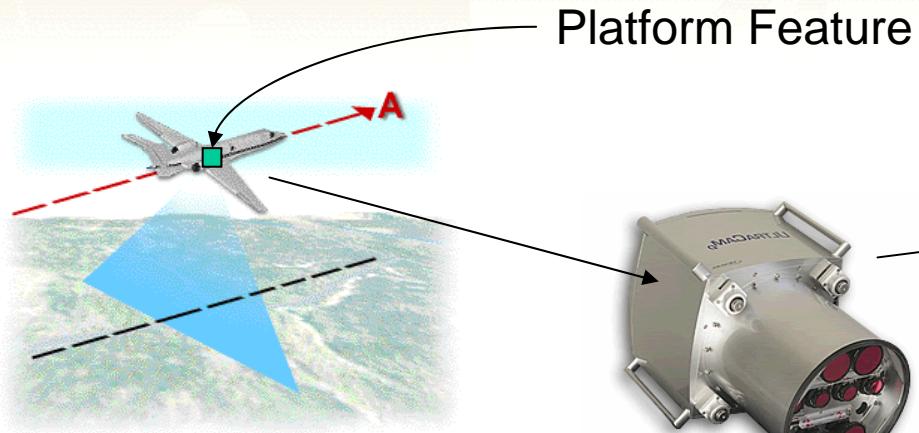
Distributions of quantities (Coverages)

What kinds of geographic things are there ?



(Observations)

GML in SensorNet Context



Coverage Feature

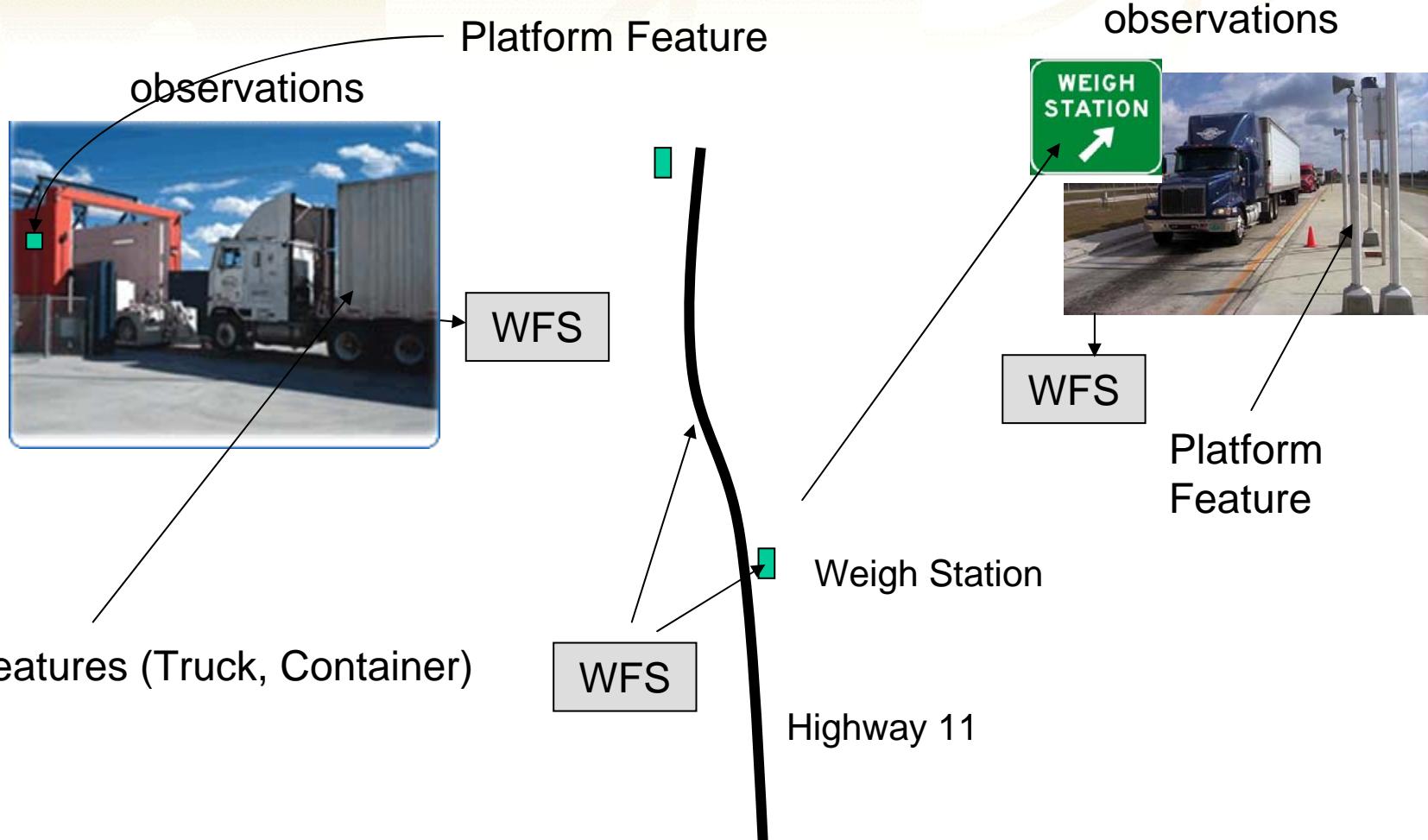


School Feature

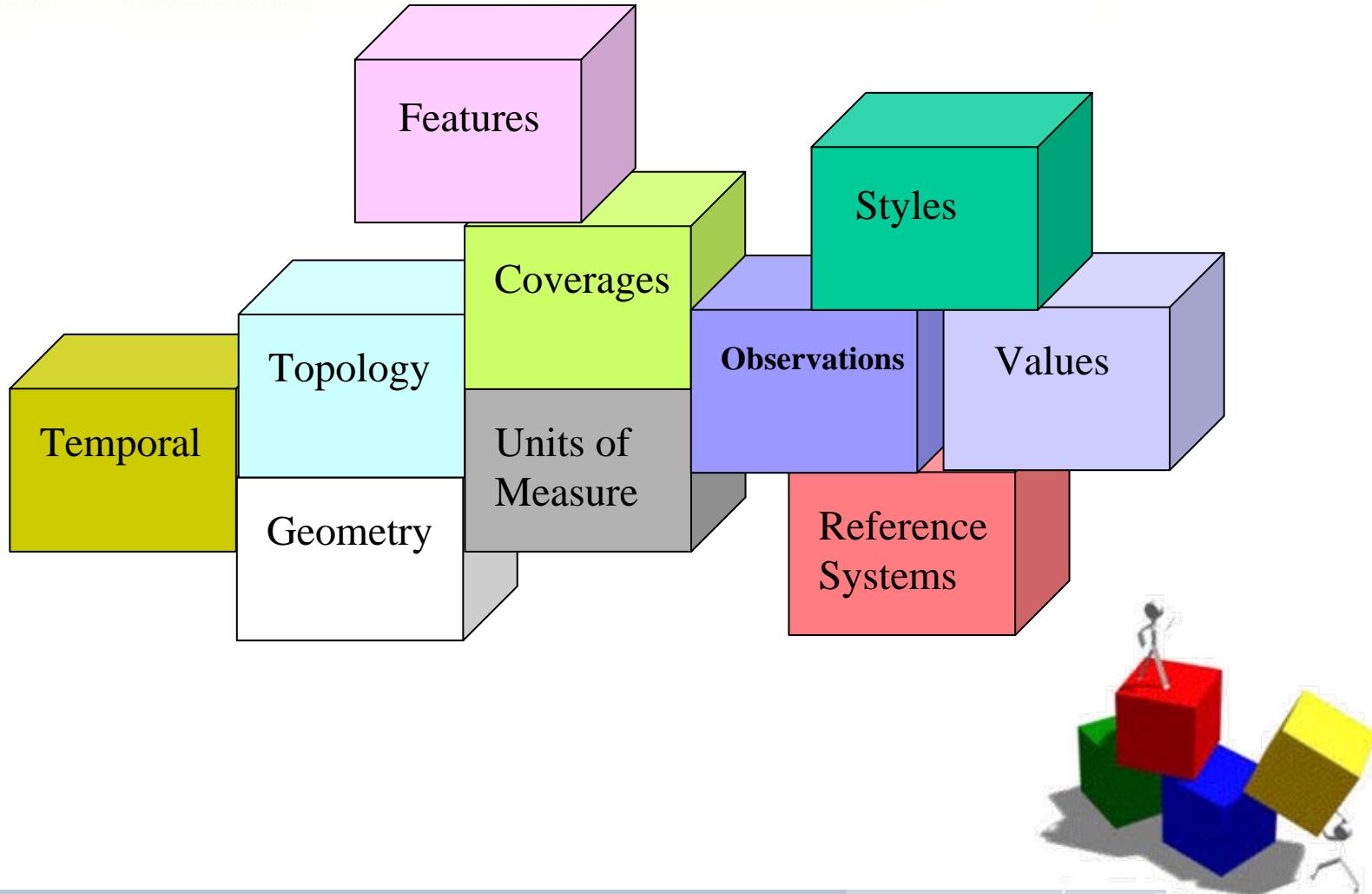
Observation Feature



GML in SensorNet Context

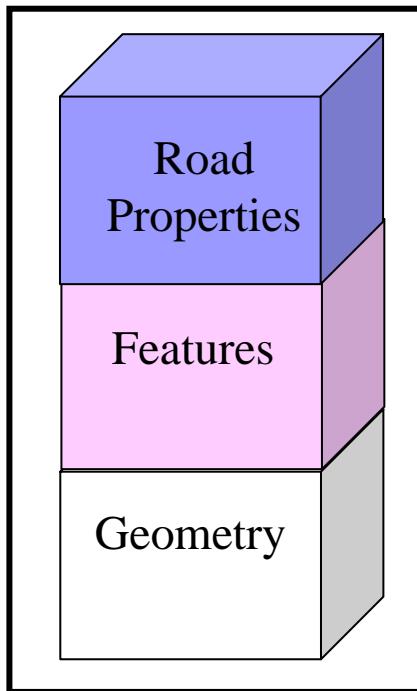


The GML Provides Building Blocks

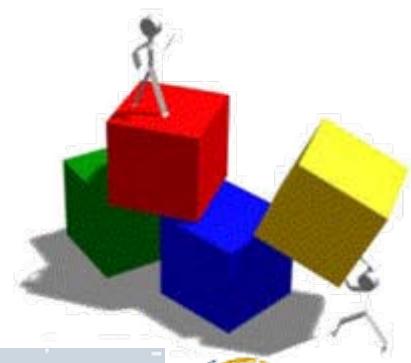
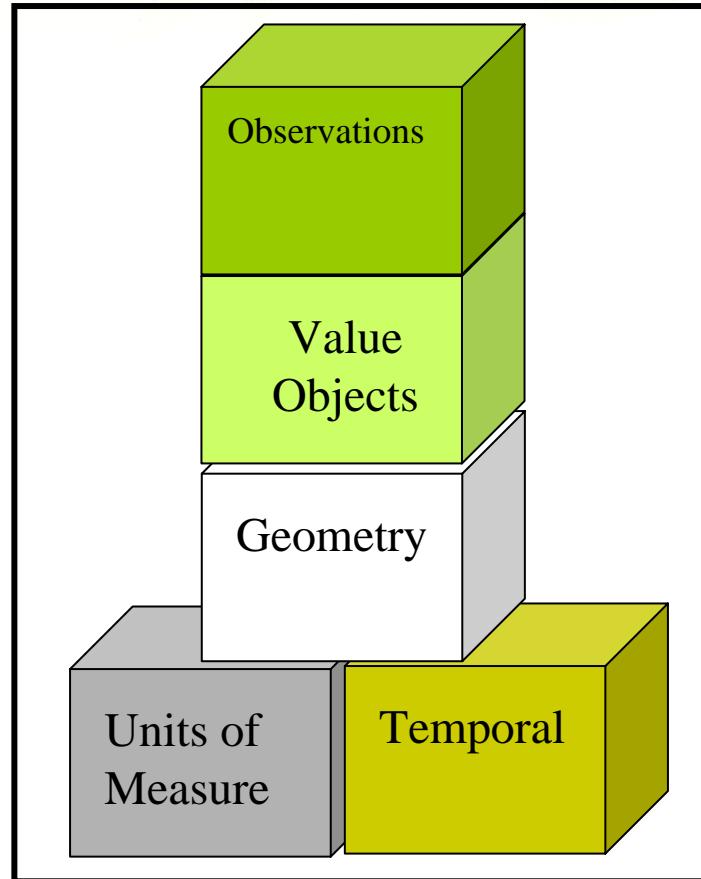


Used to Build Application Vocabulary – e.g. Sensor Data

Forest Access Road



**Radiation
Sensor Data**



SensorNet can provide its own vocabulary

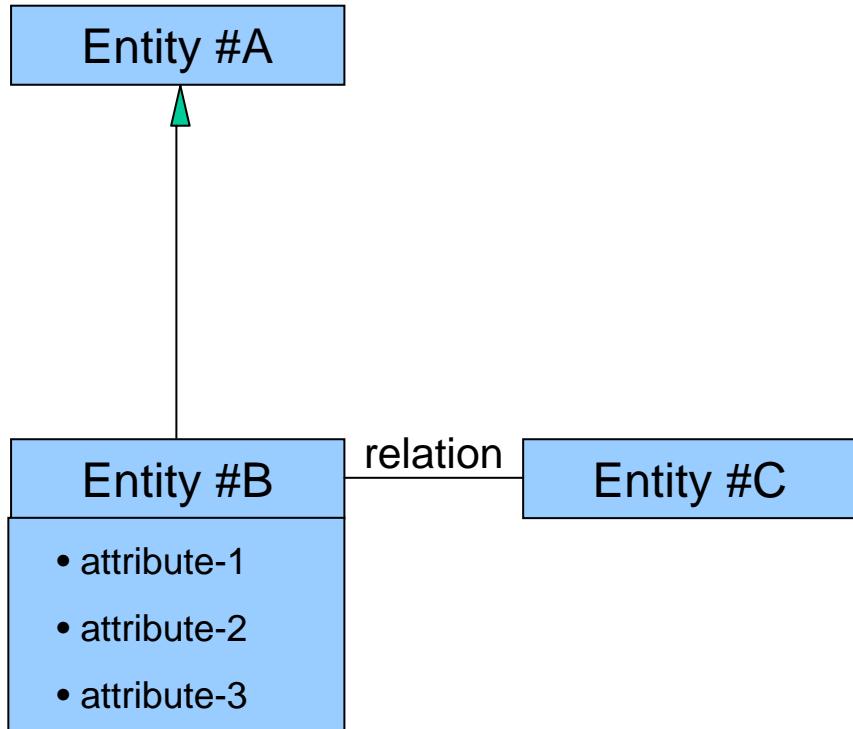
GML is a language to write Geo-languages

User or Community Defined Vocabulary

Sensor Net Vocabulary
(e.g. ANSI 42.42)

SensorNet Profile of GML

GML Model



```
<Entity gml:id = "#A">
```

...

```
</Entity>
```

```
<Entity gml:id = "#B">
```

```
  <attribute-1>...</attribute-1>
```

```
  <attribute-2> .. </attribute-2>
```

```
  <attribute-3> .. </attribute-3>
```

```
  <relation xlink:href = "#C"/>
```

```
</Entity>
```

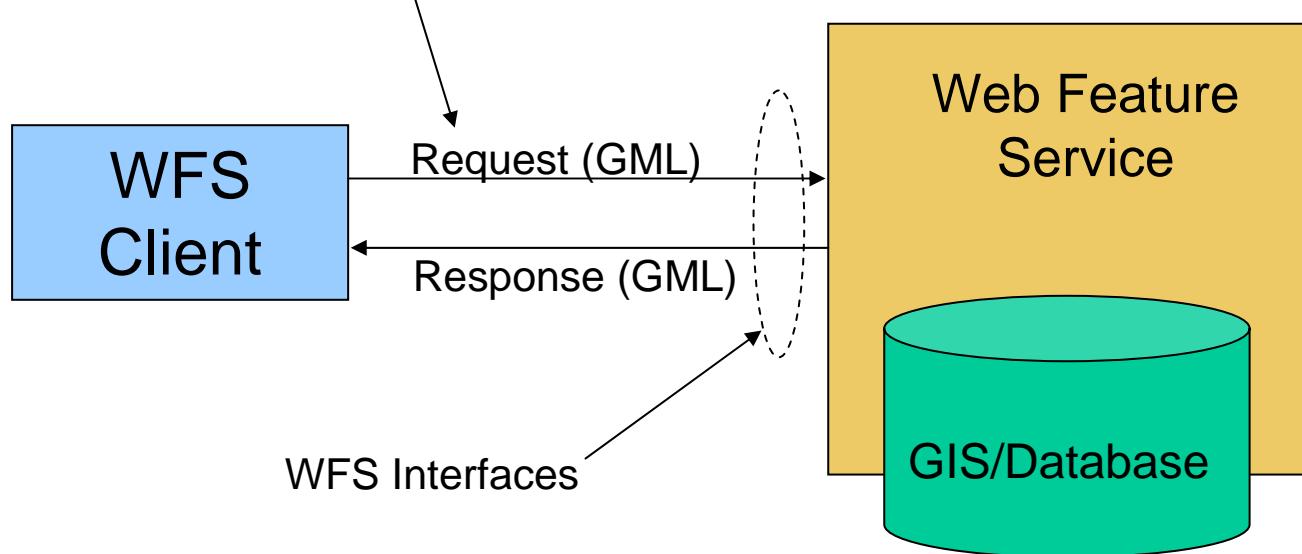
```
<Entity gml:id="#C">
```

...

```
</Entity>
```

WFS(-T) Model – Data Access Viewpoint

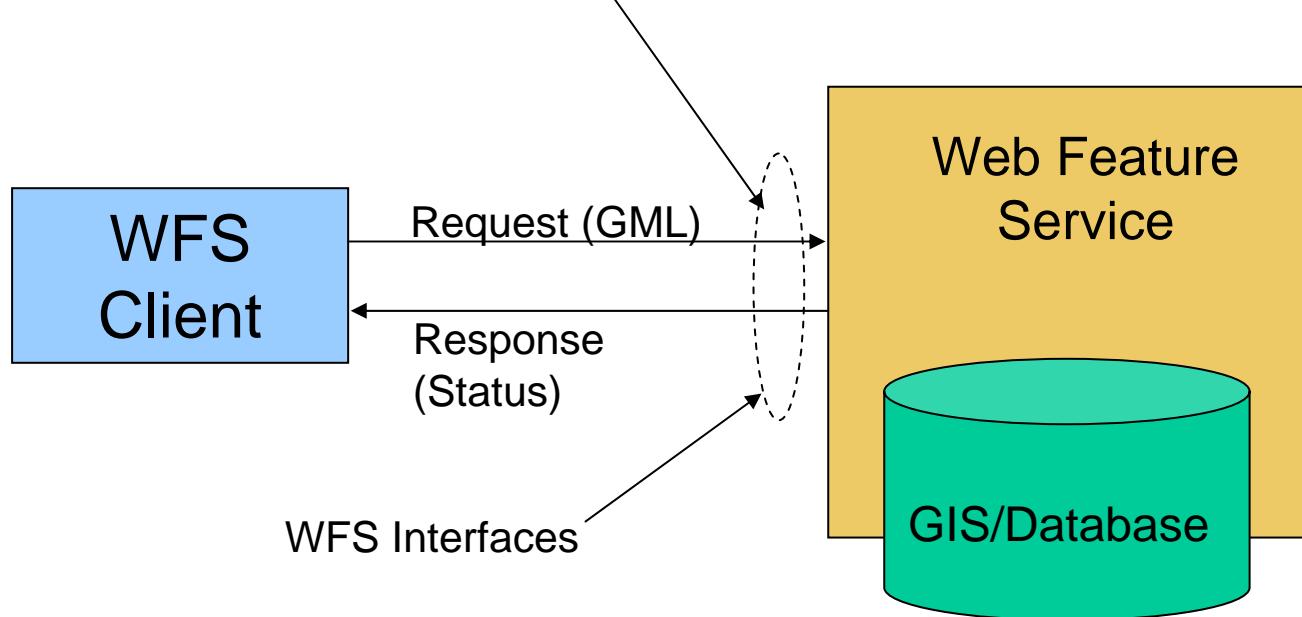
Spatial and non-spatial query



Vendor Neutral Interfaces to access Geospatial Information

WFS(-T) Model – Data Transaction Viewpoint

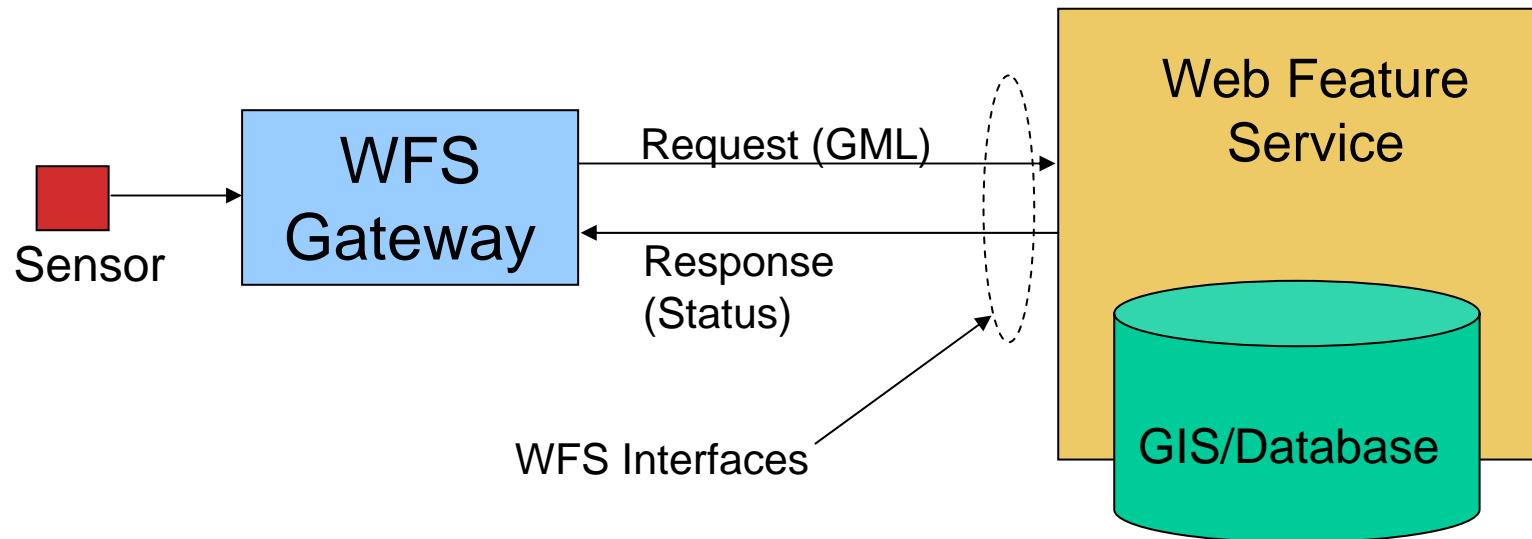
e.g. Insert Road, Update NavAid



Vendor Neutral Geospatial Transactions across the Internet

WFS(-T) Model – Sensor Context

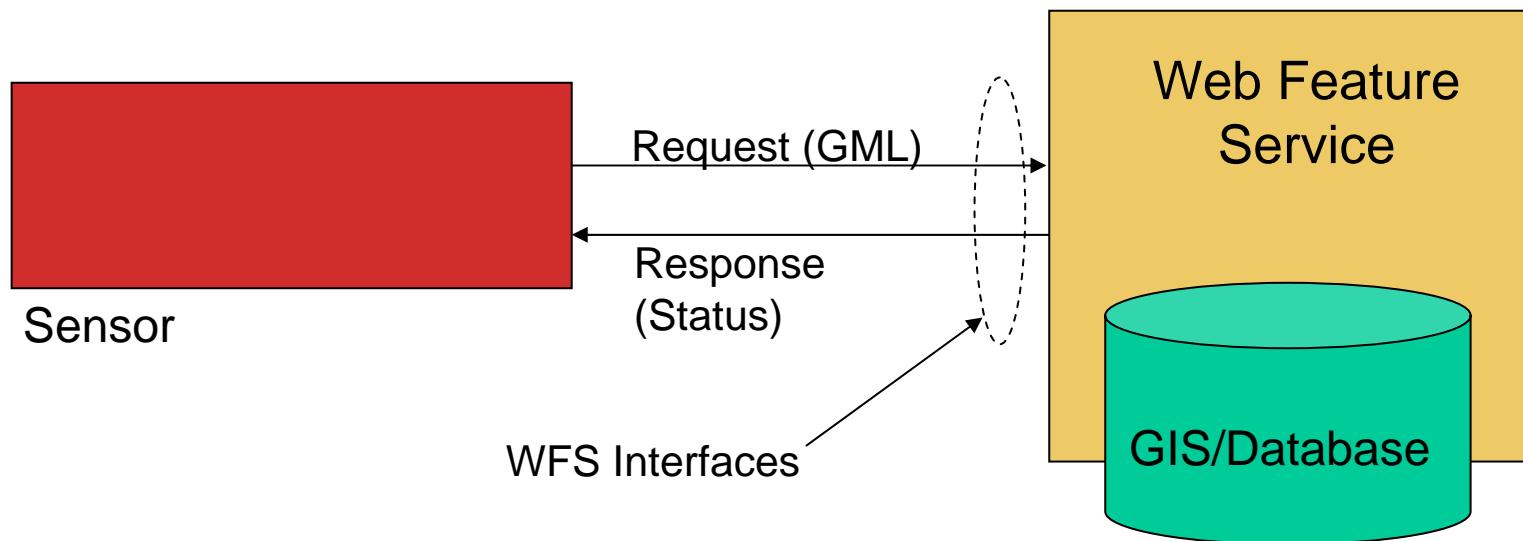
Integrate conventional geographic information & sensor data in ONE component !!



Sensor Neutral data transmission/recording across the Internet

WFS(-T) Model – Sensor Context

Integrate conventional geographic information & sensor data in ONE component !!



Sensor Neutral data transmission/recording across the Internet

WFS(-T) Interfaces

- **GetCapabilities()**
 - Query service – what can it do?
 - Get list of feature types supported
- **DescribeFeatureType()**
 - GML Application Schema
- **GetFeature()**
 - Returns features (FILTER) as GML
- **Transaction()**
 - Insert, Update, Delete, Lock features (FILTER) (GML)

GML and WFS as Standards

- **GML**
 - V1.0 (2000), V2.0 (2001), V3.0 (2003), V3.1 (2005)
 - Current version of GML is v3.1.1.
 - Adopted Specification of the Open Geospatial Consortium.
 - v3.2 complete and also issued as ISO 19136 (DIS)
- **WFS**
 - Current version of WFS is v1.1
 - Adopted Specification of Open Geospatial Consortium.
 - V1.2 is under development and WILL likely be issued as ISO 19142 (Filter is related and WILL likely be ISO 19143).

Features in WFS 1.2 for SensorNet

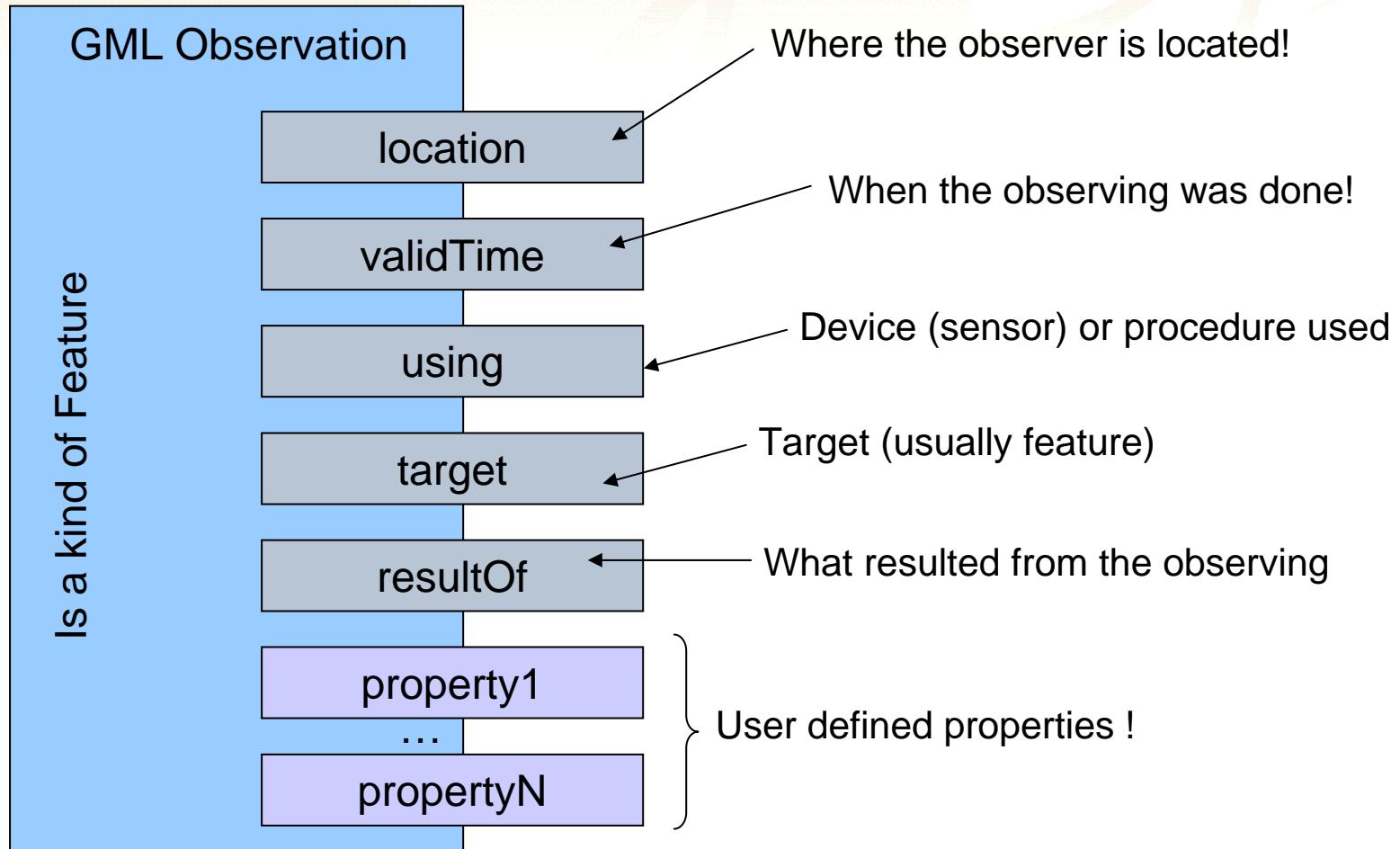
- Support GML v3.2.
- Temporal operators – Temporal Data Type
- Better collection semantics.
- Fine Grained GML Object Support (Update..)
- SortBy support.
- Clearer XPath semantics.

GML Observations

Basics of WFS in the SensorNet



GML Observations – Models Act of Observing/Measuring



Core observation type can be used as is or extended for application specific usage!

GML Observation – Simple Schema – Weak Typing

```
<Observation gml:id="O1" xmlns="http://www.opengis.net/gml" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:gml="http://www.opengis.net/gml" xmlns:bmgs="http://www.bmgs.com" xsi:schemaLocation="http://www.opengis.net/gml MyObservations.xsd">
    <validTime>
        <TimeInstant gml:id="t01">
            <gml:timePosition>2008-09-06T13:01</gml:timePosition>
        </TimeInstant>
    </validTime>
    <resultOf>
        <bmgs:MyValues gml:id="p1" aggregationType="sequence">
            <gml:valueComponent>
                <gml:Boolean>true</gml:Boolean>
            </gml:valueComponent>
            <gml:valueComponent>
                <gml:Boolean>true</gml:Boolean>
            </gml:valueComponent>
            <gml:valueComponents>
                <gml:Boolean>true</gml:Boolean>
                <gml:Boolean>false</gml:Boolean>
                <gml:Quantity uom="meters">145.6</gml:Quantity>
                <gml:Count>240</gml:Count>
            </gml:valueComponents>
        </bmgs:MyValues>
    </resultOf>
</Observation>
```

GML Observation – Simple Schema – Stronger Typing

```
<Observation gml:id="O1" xmlns="http://www.opengis.net/gml" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:gml="http://www.opengis.net/gml" xmlns:bmgs="http://www.bmgs.com" xsi:schemaLocation="http://www.opengis.net/gml MyObservations.xsd">
    <validTime>
        <TimelInstant gml:id="t01">
            <gml:timePosition>2008-09-06T13:01</gml:timePosition>
        </TimelInstant>
    </validTime>
    <resultOf>
        <bmgs:MyValues gml:id="p1" aggregationType="sequence">
            <gml:valueComponent>
                <gml:Boolean>true</gml:Boolean>
            </gml:valueComponent>
            <gml:valueComponent>
                <gml:Boolean>true</gml:Boolean>
            </gml:valueComponent>
            <gml:valueComponents>
                <gml:Boolean>true</gml:Boolean>
                <gml:Boolean>false</gml:Boolean>
                <gml:Quantity uom="meters">145.6</gml:Quantity>
                <gml:Count>240</gml:Count>
                <bmgs:Radiation uom="mrad">100</bmgs:Radiation>
            </gml:valueComponents>
        </bmgs:MyValues>
    </resultOf>
</Observation>
```

GML Observation – Simple Schema

Simple Schema – Weakly Typed – Slightly stronger typing

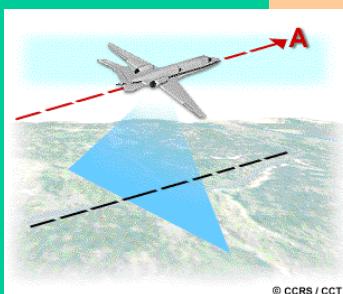
```
<xs:schema targetNamespace="http://www.bmgs.com" xmlns:gml="http://www.opengis.net/gml"
xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns:bmgs="http://www.bmgs.com"
elementFormDefault="qualified" attributeFormDefault="unqualified">
    <xs:import namespace="http://www.opengis.net/gml" schemaLocation="C:\Galdos\RandD\GML\gml
3.2\gml\gml.xsd"/>
        <xs:element name="MyValues" type="gml:CompositeValueType"
substitutionGroup="gml:AbstractObject"/>
            <xs:element name="Radiation" type="gml:MeasureType" substitutionGroup="gml:AbstractValue"/>
</xs:schema>
```

GML Observation – Data Blocks

```
<Observation xmlns="http://www.opengis.net/gml"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:gml="http://www.opengis.net/gml"
  xmlns:bmgs="http://www.bmgs.com"
  xsi:schemaLocation="http://www.opengis.net/gml
  C:\Galdos\RandD\GML\GML31~1.1\3.1.1\3.1.1\MyDataBlock.xsd">
  <validTime>
    <TimeInstant gml:id="t01">
      <gml:timePosition>2008-09-06T13:01</gml:timePosition>
    </TimeInstant>
  </validTime>
  <resultOf>
    <bmgs:MyDataBlock>
      <rangeParameters>
        <CompositeValue>
          <valueComponents>
            <bmgs:Temperature uom="#degC"/>
            <bmgs:Pressure uom="#millibars"/>
          </valueComponents>
        </CompositeValue>
      </rangeParameters>
      <tupleList>100,200 200,300 159.1,44.23 129.2,652.3</tupleList>
    </bmgs:MyDataBlock>
  </resultOf>
</Observation>
```

The diagram illustrates the structure of the GML Observation XML. The XML code is contained within a purple rectangular area. A specific section of the XML, which defines a data block, is highlighted with an orange rectangle. This highlighted section starts with the opening tag `<bmgs:MyDataBlock>` and ends with the closing tag `</bmgs:MyDataBlock>`. Inside this block, the `<rangeParameters>` and `<CompositeValue>` elements are also highlighted with the same orange color. Below this orange-highlighted area, the `<tupleList>` element and its content are highlighted with a yellow rectangle. Two arrows originate from the right side of the slide and point towards these highlighted sections. The top arrow points to the orange-highlighted area and is labeled "Data Header". The bottom arrow points to the yellow-highlighted area and is labeled "Data Values".

```
<Observation xmlns="http://www.opengis.net/gml" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:gml="http://www.opengis.net/gml" xmlns:bmgs="http://www.bmgs.org" xsi:schemaLocation="http://www.bmgs.org
  C:\Galdos\RandD\GML\GML31~1.1\3.1.1\3.1.1\AirPhoto.xsd">
  <validTime>
    <TimeInstant gml:id="t01">
      <gml:timePosition>2008-09-06T13:01</gml:timePosition>
    </TimeInstant>
  </validTime>
  <resultOf>
    <bmgs:AirPhoto>
      <name>Sample air photo</name>
      <domainSet>
        <Grid dimension="2">
          <limits>
            <GridEnvelope>
              <low>0 0</low>
              <high>1280 1024</high>
            </GridEnvelope>
          </limits>
          <axisName>x</axisName>
          <axisName>y</axisName>
        </Grid>
      </domainSet>
      <rangeSet>
        <File>
          <rangeParameters>
            <CompositeValue>
              <valueComponents>
                <bmgs:Radiance uom="#counts"/>
              </valueComponents>
            </CompositeValue>
          </rangeParameters>
          <fileName/>
          <fileStructure>Record Interleaved</fileStructure>
        </File>
      </rangeSet>
    </bmgs:AirPhoto>
  </resultOf>
</Observation>
```



GML Observation – Coverage Valued - Schema

```
<xs:schema targetNamespace="http://www.bmgs.org" xmlns:bmgs="http://www.bmgs.org"
xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns:gml="http://www.opengis.net/gml"
elementFormDefault="qualified" attributeFormDefault="unqualified">
    <xs:import namespace="http://www.opengis.net/gml" schemaLocation="base\gml.xsd"/>
    <xs:element name="AirPhoto" type="bmgs:AirPhoto" substitutionGroup="gml:_Object"/>
    <xs:complexType name="AirPhoto">
        <xs:complexContent>
            <xs:extension base="gml:AbstractCoverageType"/>
        </xs:complexContent>
    </xs:complexType>
    <xs:element name="Radiance" type="bmgs:Radiance" substitutionGroup="gml:_Object"/>
    <xs:complexType name="Radiance">
        <xs:simpleContent>
            <xs:extension base="gml:MeasureType"/>
        </xs:simpleContent>
    </xs:complexType>
</xs:schema>
```

Other Observation Schema

- e.g. O&M Observation (OGC)
- Other feature non-GML observations

Can be used in WFS if are valid GML

May not be recognized as observations!!

WFS (-T) and the SensorNet



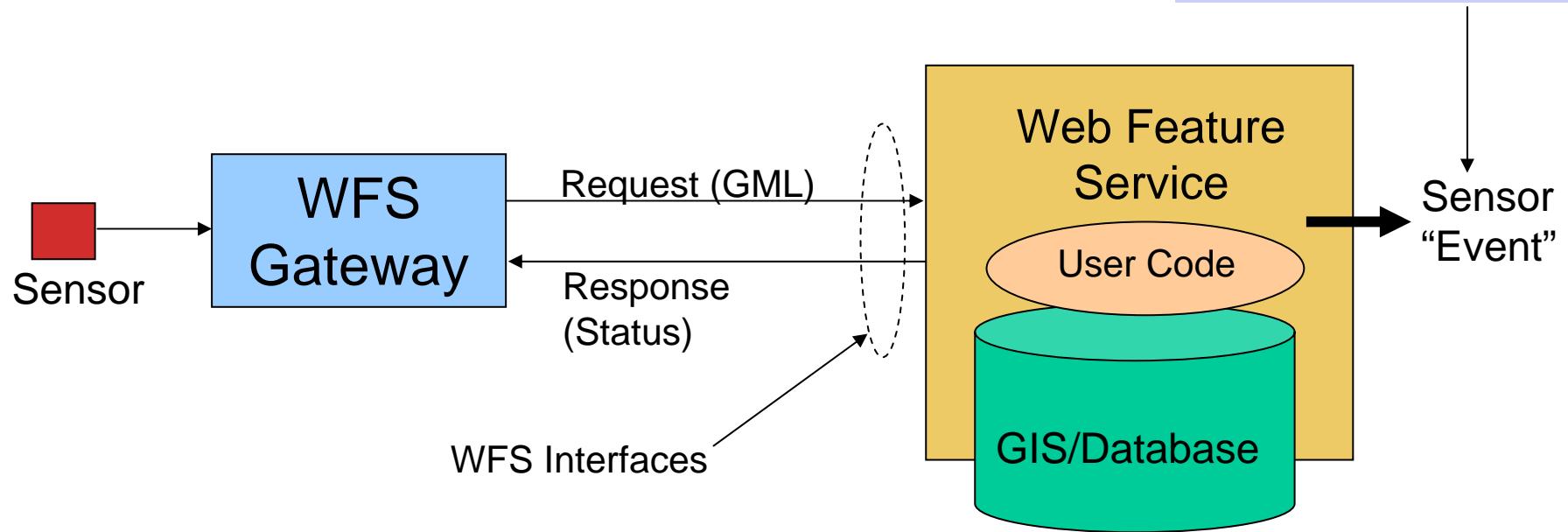
Features of Galdos Cartalinea™ for sensor webs

- Feature (hence observation) **replication**.
- **Listener** – user defined response to changes in observation data → Alerts & Notification
- X-Hive version – support more or less **any** GML Application Schema out of the box!!
- Oracle mapping tools – new version (**not released**)
- Output **event pipeline** – any size data.
- User defined **transformations** in output pipeline.

WFS(-T) Model – Sensor Context

Notifications and Alerts based on changes in Sensor Data

Can be transaction
replicate, e-mail,
soap message etc.

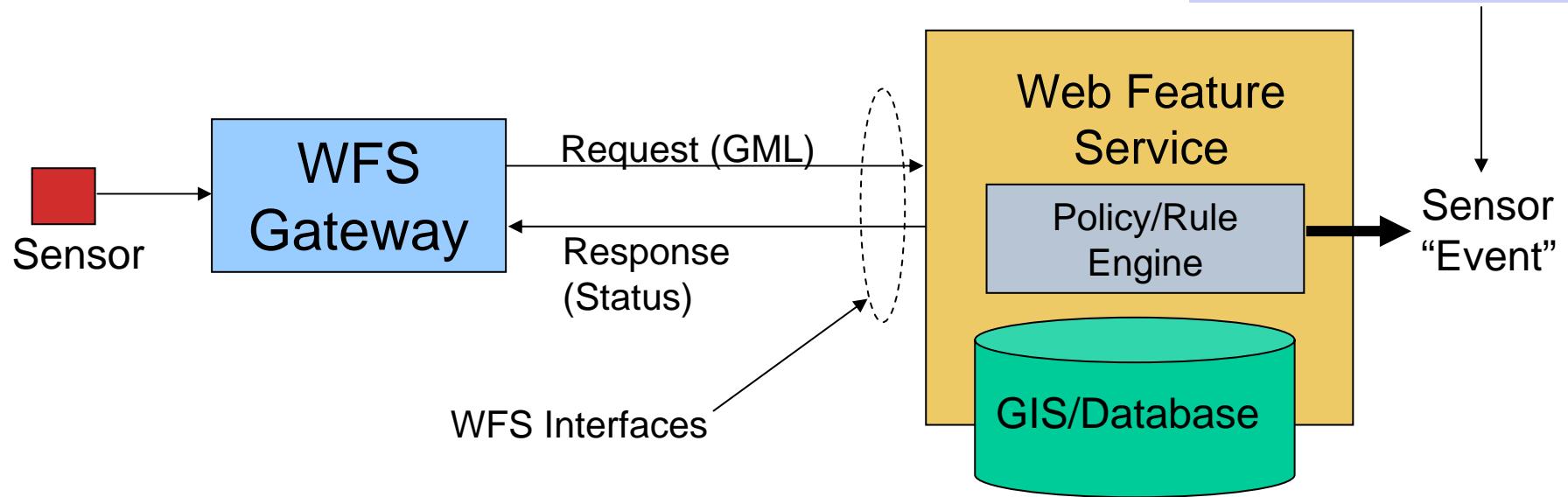


Sensor Neutral data transmission/recording across the Internet

WFS(-T) Model – Sensor Context – Coming Soon!

Notifications and Alerts based on changes in Sensor Data

Can be transaction
replicate, e-mail,
soap message etc.



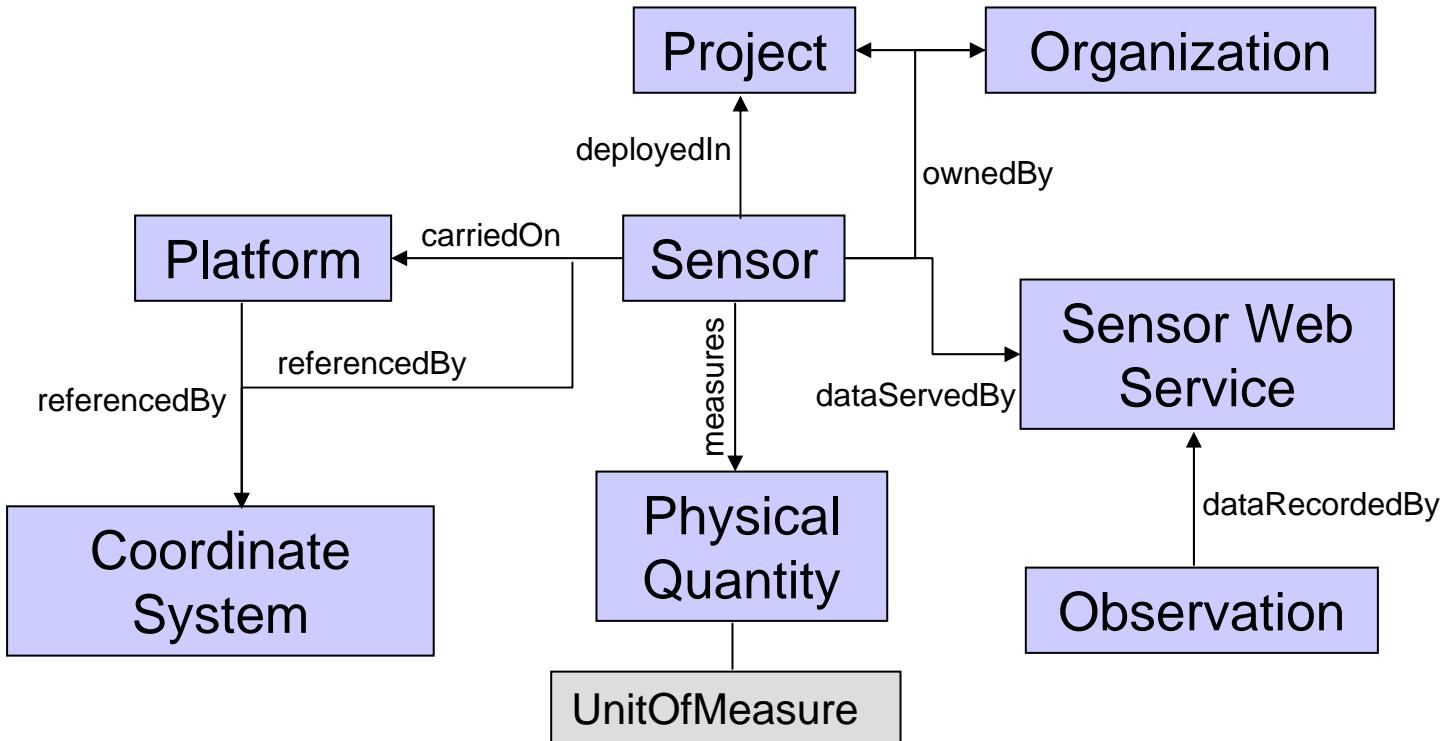
User defined Action Rules and Standard/User Defined Responses

WFS, WRS and the SensorNet

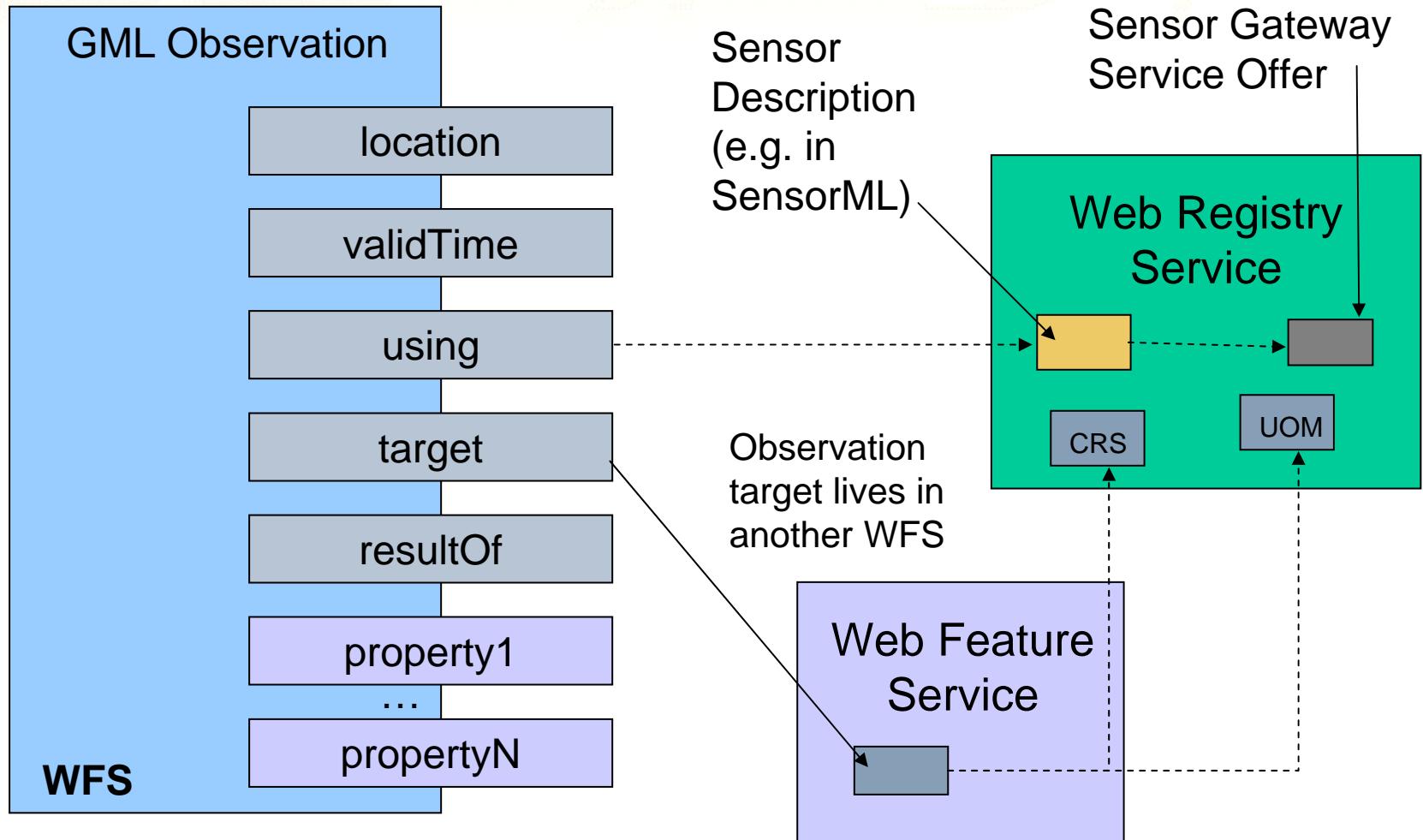


Web Registry Service and SensorNet

- Sensors don't exist in isolation.
- Context (metadata) determines the real value of sensor data.



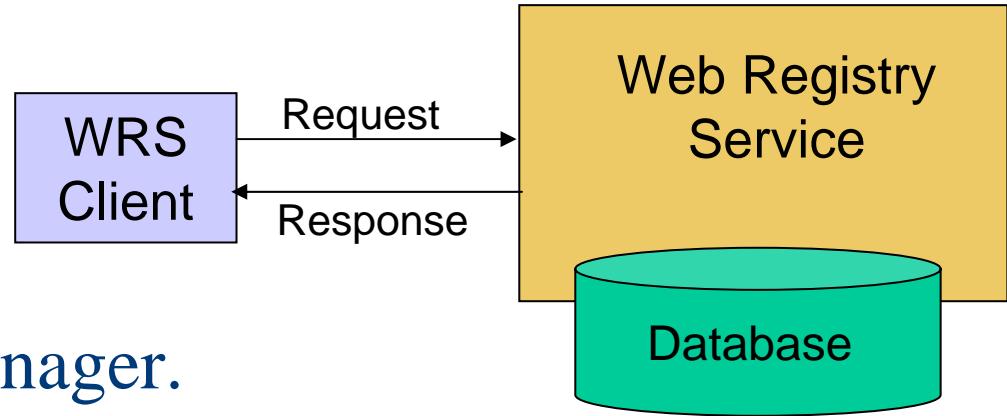
GML Observation and Web Registry Service



What is a Web Registry Service?

- A general metadata “catalogue” – extends OGC Catalogue

- Really MUCH more!



- A general artifact manager.

- Based on **OASIS ebRIM v3.0** with spatial operators & transaction support.

What is a Web Registry Service?

- Built-in support for:
 - **User defined taxonomies** (classification schemes) – e.g. classify sensors by type – by quantity measured etc.
 - **User defined associations** (link from quantity measured to service offer to platform & sensor description)
 - **User defined packages** – logical collections of registry objects.
 - **Audit Trail** = who changed what and when
 - **Transactions** – machine read/write of metadata.
 - **Life Cycle Metadata** – version. stability etc.
 - SAML-based Security (Galdos).
 - Automated data harvesting.

Web Registry Service (WRS) deployment

- Easily support a rich set of artifacts:
 - Service offers (service interface descriptions – e.g. WSDL – ISO 19119)
 - Data set descriptions (NATO)
 - Coordinate Reference Systems (Shell/OGP/NATO)
 - Units of Measure Definitions (Shell/OGP/NATO)
 - Sensor Descriptions (SensorML ..)
 - Platform Descriptions
 - Organizations (built in)
 - Image Descriptions (ESA)
 - Map Styles and Symbology
- Build extended E-R model.
- Encapsulate in ebRIM grammar.
- Deploy in WRS.

Summary

- WFS(-T) ready today for near real time sensor data acquisition.
- Multiple commercial and open source WFS-T available today.
- Builds on GML Observations (GML 3.1.1)
- Cartalinea offers advanced features like replication and programmable alert/notification, data transformation → policy/rule engine soon.
- Complemented by **WRS** for Sensor metadata!!